Joint ITU-IEICE-CTIF-GISFI Workshop on Education about Standardization

Kyoto, Japan, 25 April 2013

Overview of IEEE Standards Education and
Emerging Ethernet Standards

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AALBORG UNIVERSITY

CTiF
Center for TeleInfrastruktur

GISFI
GLOBAL ICT STANDARDIZATION FORUM FOR INDIA

ITU

Before I Share <u>My</u> Views...

"At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position, explanation, or interpretation of the IEEE."

IEEE-SA Standards Board Operation Manual (subclause 5.9.3)

Agenda

Overview of IEEE Standards Education

Overview of Emerging Ethernet Technologies

Ethernet's 40th Anniversary

Concluding remarks

IEEE Standards Education

- IEEE Standards Education is a joint activity of IEEE Educational Activities and IEEE Standards Association
  - Oversight by IEEE Standards Education Committee (SEC)
- The Mission of the IEEE SEC:
  - Promote the importance of standards in meeting technical, economic, environmental, and societal challenges.
  - Secure and disseminate learning materials on the application of standards in the design and development aspects of educational programs.
  - Secure and provide short courses about standards needed in the design and development phases of professional practice.
  - Actively promote the integration of standards into academic programs.

Why Standards Education is Important

- **Standards Education** recognizes the key role standards play within the engineering, technology and computing fields.

- Knowledge of standards can help facilitate the transition from classroom to professional practice by aligning educational concepts with real-world applications.

- Incorporating standards into the curriculum …
  - ➡ Benefits students and faculty mentors as they face challenging design processes
  - ➡ Provides tools for use in learning about standards and their impact on design and development

IEEE Position Paper

- Paper on the Role of Technical Standards in the Curriculum of Academic Programs in Engineering, Technology and Computing (ETC)
- As part of the effort to actively promote the integration of standards into academic programs
    - Approved on 28th June 2009 by IEEE Board of Directors
    - Position paper was also endorsed by the IEEE Educational Activities Board and the IEEE Standards Board of Governors
- http://www.ieee.org/documents/standardsposi tionpaper_approvedjune09.doc

Standards & the Engineering Student

- Will the working engineer use standards in his or her everyday professional life?

- **Yes! Almost every day** according to industry experts. Most aspects of business are impacted by standards.

- And yet, most engineering students have little to no exposure to standards in their undergraduate or even graduate careers.

- An engineer who understands something about standards before entering the workforce is more valuable to his or her company.

Resources for Academia

- Creating resources for academia has been a primary focus of IEEE SEC activity.

- "Educators Resource Library" consolidates materials.

- Professors will remain a key stakeholder for this activity

http://www.standardseducation.org

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IEEE Standards Education eZine

- Free
- Publicly available
- Worldwide audience of educators, students, and practicing professionals
- Gives 6 to 9 months for scheduling its release, researching the background, reviewing the text, consulting authors about review, etc.

- Feature articles
- Interviews
- SEC-approved final student application papers
- Case studies
- News briefs
- Editor-in-Chief's page

- http://ieee-elearning.org/outreach/course/view.php?id=1343

Example of a Popular Workshop Topic

Demystifying IEEE 802 Standards =
Full day immersion into IEEE 802®
Standards; covers all the IEEE
working groups developing standards
in both the wired and wireless areas

IEEE Grants & Student Application Papers

SEC offers grants to students & faculty members

- $500 USD grants for students
- $300 USD grants for faculty advisors
- Projects illustrate how specific standards were applied to a task in the classroom
- Students and/or faculty describe how standards impacted the design process
- Results are published as Student Application Papers

Standards Education Internship

- Pilot program is targeted to engineering students, faculty, and universities in India.

- Offers a 6-month internship working for a corporate sponsor.

- Intern/sponsor match is facilitated via IEEE Standards Education Internship Bureau, a matchmaking service that helps bring together companies and students.

- High-quality matches are the goal.

- Program may expand beyond India.

Work in Progress

- Case Studies book to be published by John Wiley & Sons August 2014

- eLearning Library modules

→ Ethics

→ How to Read a Standard

→ How to Use a Case Study

- Chapter on Standards for existing popular engineering texts

- More video content planned
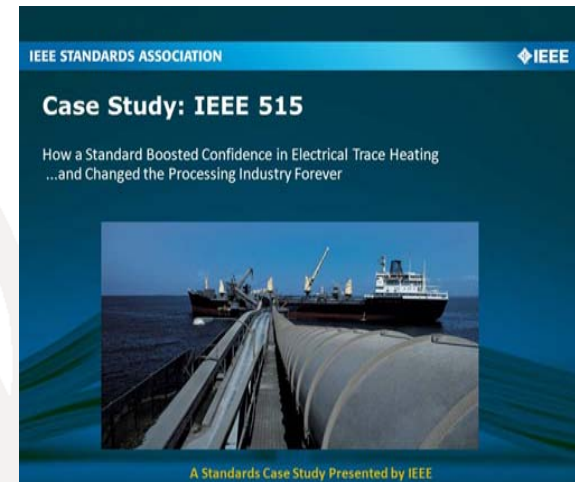
Linking Standardization & Research

IEC-IEEE Challenge

In 2011-2012, IEEE partnered with IEC on a global initiative that invited the world's academic institutions to analyze and debate the impact of electrotechnology on the economic, social and environmental development of nations and regions, including how accepted standards affect this process.

SIIT Conference

IEEE is the technical and financial sponsor of the Standardization and Innovation in Information Technology (SIIT) Conference. This forum, meeting every two years since 1999, aims to bring together standardization researchers from different disciplines (IT practitioners, policy makers, standards developers and users) to discuss theory, practice, and research issues in standardization.

Agenda

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Concluding remarks

Ethernet: History and Relation to 802

- 2013 is 40th Anniversary of Ethernet!!
  - Ethernet invented in 1973
- History of LMSC
  - 1st meeting Feb 1980. Originally known as the Technical Committee on Computer Communications (TCCC or "T-Triple-C"). Originally LAN, MAN scope added later
- LMSC consists of
  - SEC (802.0): Sponsor Executive Committee
  - WGs/TAGs (802.x): Working Groups and Technical Advisory Groups
- Examples of Active WGs/TAGs
  - Notice the historic success of *odd* numbered groups!
  - 802.1, 802.3, 802.11, 802.15, 802.16, 802.17, 802.18, 802.19, 802.20, 802.21

IEEE 802

- Application agnostic
- Diverse set of world-renowned wired and wireless communication interfaces
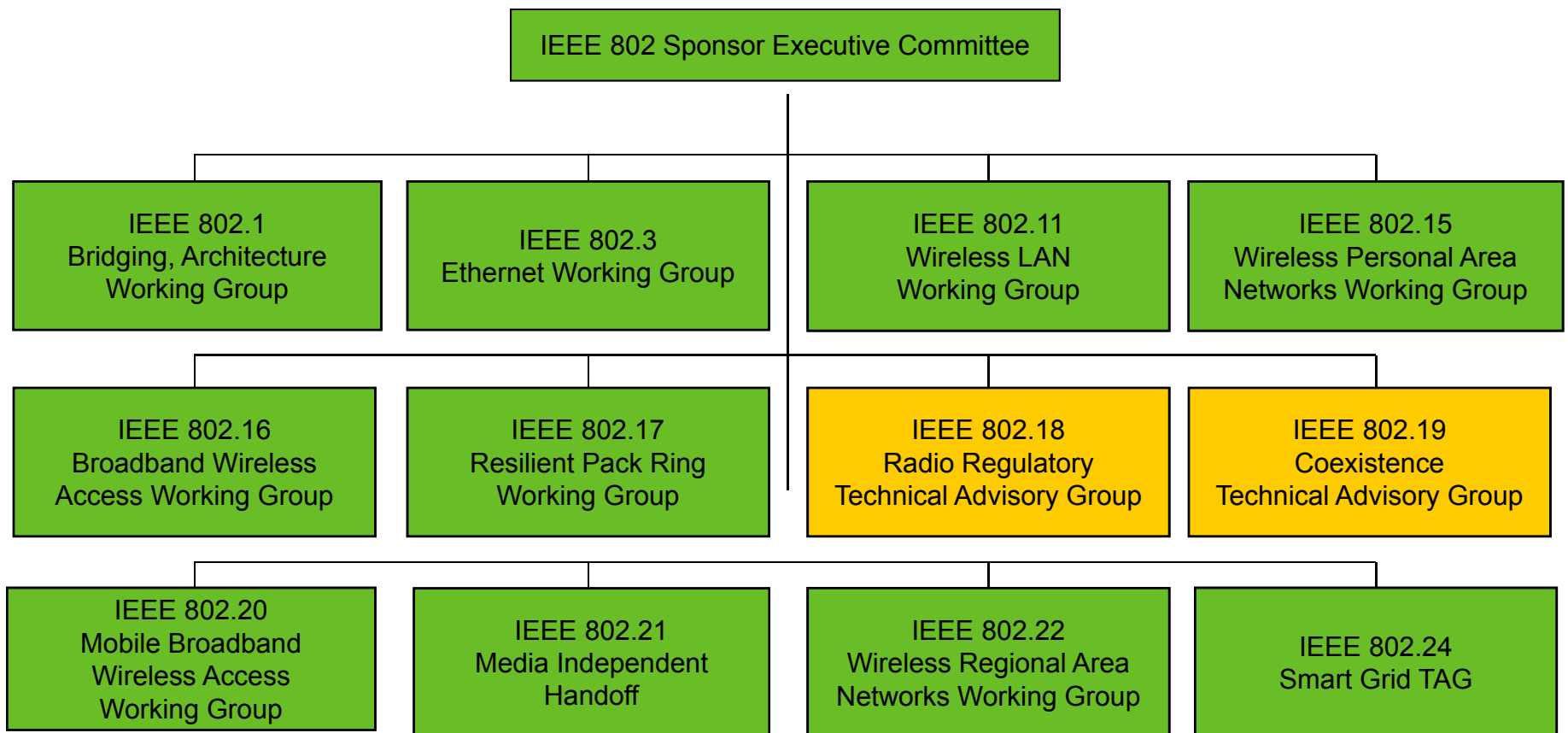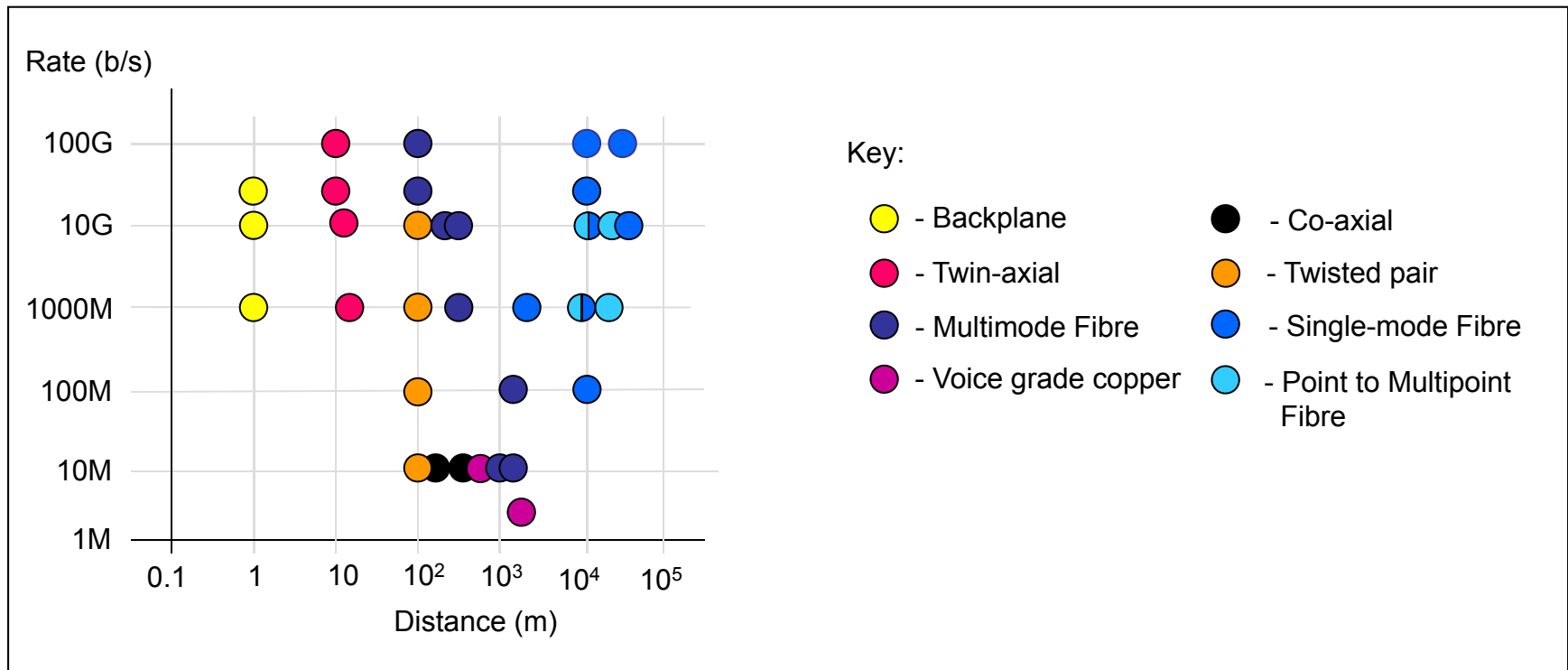
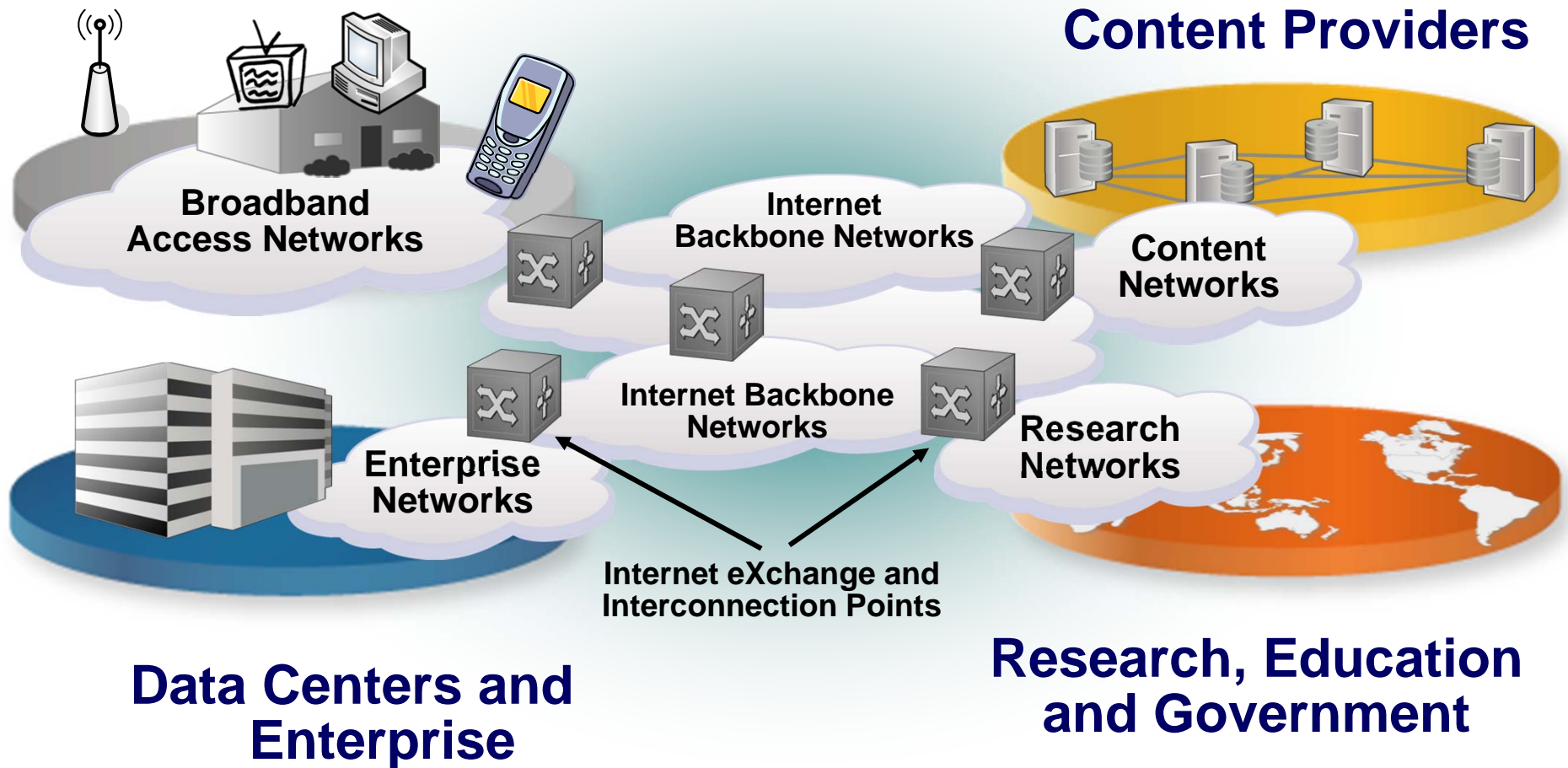Why Ethernet is the Ubiquitous Wired Networking Technology

EVOLUTION OF ETHERNET

IEEE 802.3 Ethernet PHY Types

Ethernet: Convergence and Leverage

Broadband Access

Content Providers

Broadband Access Networks

Internet Backbone Networks

Content Networks

Enterprise Networks

Internet Backbone Networks

Research Networks

Internet eXchange and Interconnection Points

Data Centers and Enterprise

Research, Education and Government

Convergence

Convergence Over Standard Ethernet — Cluster IPC, Storage, LAN, Management
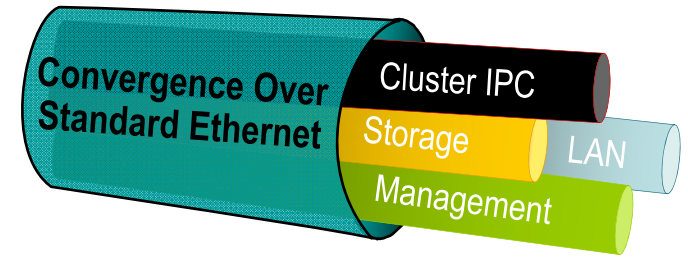
- **Connectivity convergence**
  - Ethernet is the ubiquitous connectivity technology
  - From the home to the core, convergence is occurring
    - Consumer, Enterprise, SP, Backhaul, Datacenter, HPC etc.
  - Drives higher volumes, lower cost
  - Eliminates unnecessary protocol conversions
  - Conventional connections *within* the home migrating to Ethernet. E.g. HDTVs already have Ethernet connectors
- Network architecture convergence
  - Different "types" of networks have increasingly more similarities than differences. E.g. access and distribution
  - Higher layer feature requirement differences certainly exist but can be transparent to the connectivity layer
- Ethernet has a well understood maturity curve

Converging Network Architectures

Core Layer

L3 Aggregation Layer
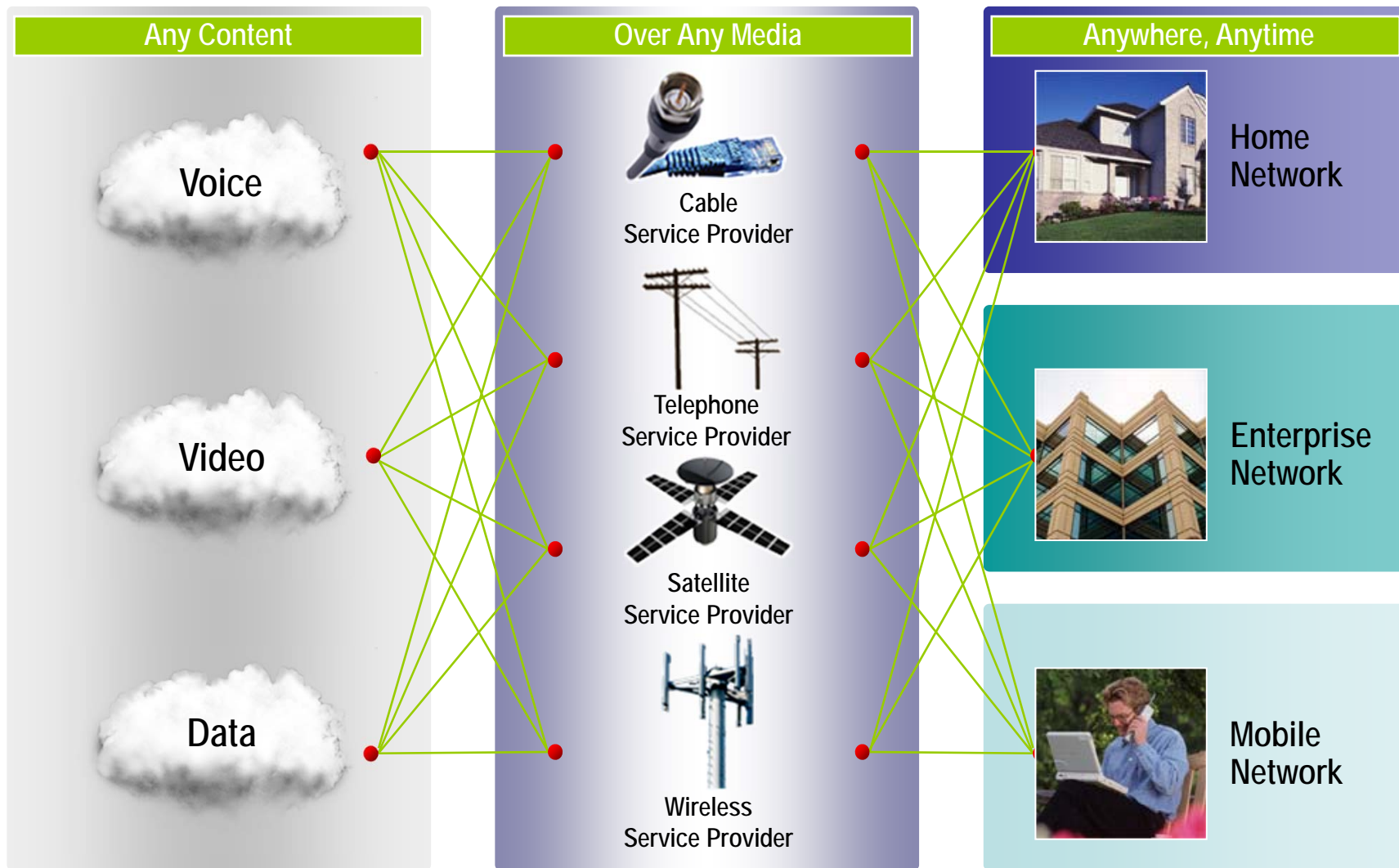
L2 Aggregation Layer

Access Layer
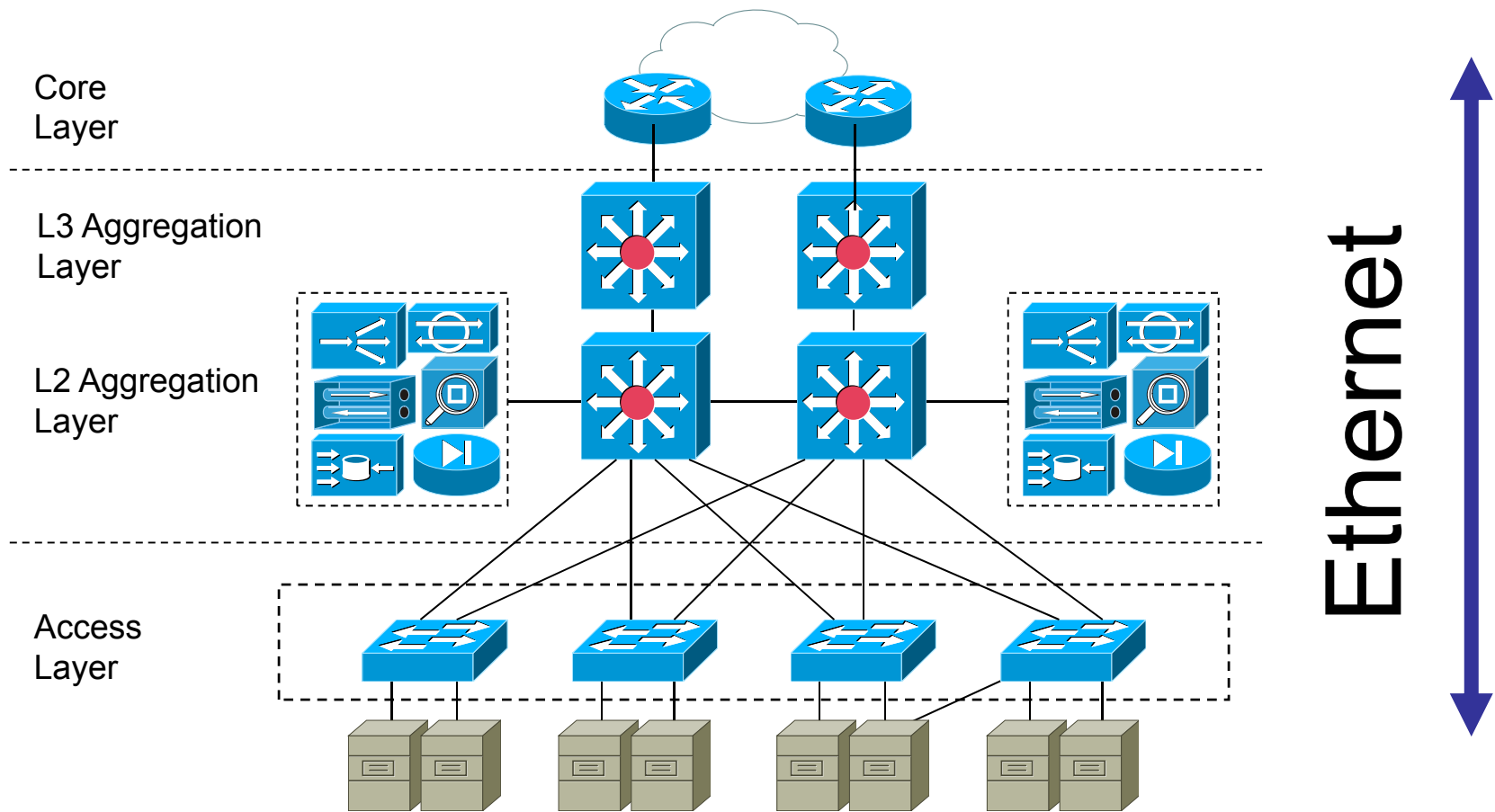
Ethernet

Similar Architectures for SP, DC, Enterprise Etc.

Leverage

- Technology leverage
  - Family of technologies running *natively* on Ethernet
    - E.g. EEE, PoEP, AVB, HSE, MACSec, Link Aggregation
  - Keeps the L2 stack simple by running native
  - Technologies are "free" when you run Ethernet
- Media leverage
  - Family of technologies supporting variety of media at each speed
  - No need to reinvent solutions for new application spaces like the home or core, simply build on Ethernet. Hybrid solutions possible
- Speed and cost point leverage
  - Family of technologies supporting variety of speeds and cost points
  - No need to reinvent solutions for new application spaces like the home or access, simply build on Ethernet
- System leverage
  - E.g. An EFM interface is a new interface to existing switch fabrics
- Si and sub-system leverage
  - E.g. Low cost 100M/1G switches, optical sub assemblies etc.

Growing Application Space:
Variety of Content, Providers, Users

Any Content

Voice

Video

Data

Over Any Media

Cable
Service Provider

Telephone
Service Provider

Satellite
Service Provider

Wireless
Service Provider

Anywhere, Anytime

Home
Network

Enterprise
Network

Mobile
Network

NEW AND INTERESTING ETHERNET PROJECTS

IEEE Std 802.3-2012

- What is this about (scope)?
  - Revision of mainline Ethernet standard
  - Published December 28th 2012
    - >3600 pages in 6 books (volumes)!
- Why should I be interested?
  - This document supersedes IEEE Std 802.3-2008, plus the following amendments and corrigendum:
    - IEEE Std 802.3av-2009 (10G-EPON)
    - IEEE Std 802.3bc-2009 (LLDP)
    - IEEE Std 802.3at-2009 (DTE power enhancements)
    - IEEE Std 802.3-2008/Cor1-2009
    - IEEE Std 802.3ba-2010 (40 Gb/s and 100 Gb/s Ethernet)
    - IEEE Std 802.3az-2010 (Energy Efficient Ethernet)
    - IEEE Std 802.3bg-2011 (Serial 40 Gb/s Ethernet)
    - IEEE Std 802.3bf-2011 (Time Synchronization Protocol Support)
    - IEEE Std 802.3bd-2011 (MAC Control Frame for Priority-based Flow Control)
- Press release announcing project
  - http://standards.ieee.org/news/2012/802.3_12.html

Award Photo from Plenary

Ethernet 40th Anniversary

- Invented 40 years ago this year!

- Has become ubiquitous wired networking connectivity of choice

- Being honored at several events throughout this year

- Most recent was award given to IEEE 802.3 Working Group from Ethernet Technology Summit

    - http://standards.ieee.org/news/2013/ethernet_summit.html

Ethernet and the Future

- Ethernet now is the biggest Working Group in 802.
  - About 33% of all 802 attendees in March plenary
- 9 simultaneously active projects
  - Connectivity at 40G/100G
    - P802.3bj (100G Cu/BP), P802.3bm (Next Generation 40G/100G optics), P802.3bq (40GBASE-T)
    - Includes but not limited to focus on datacenters
  - Automotive: P802.3bp (RTPGE)
  - Industrial and automotive control: DMLT SG
  - Access: P802.3bk (Extended EPON) and P802.3bn (EPoC)
  - Bandwidth: 400 Gb/s Ethernet SG
  - Power: 4-Pair PoE SG and PoDL CFI
  - Energy efficiency
  - Management: P802.3.1 Rev

Green: Emerging EEE Technologies

- Since IEEE Std 802.3az-2010, EEE has become a mainstream requirement
  - IEEE Std 802.3az-2010 now part of IEEE Std 802.3-2012
- Major new projects with EEE objectives
  - IEEE P802.3bj (100G Cu/BP)
  - IEEE P802.3bm (40G/100G Next Gen Optics)
  - IEEE P802.3bn (EPoC)
  - IEEE P802.3bp (RTPGE)
  - IEEE P802.3bq (40GBASE-T)

IEEE P802.3bj: 100G CU and BP

- What is this about (scope)?
  - Add 4-lane 100G interfaces for operation over backplane and twinax cables
- Why should I be interested?
  - This interconnect technology will be used in future higher speeds systems such as those in a datacenter on both the backplane as well as topologies like TOR
  - FEC technique
  - EEE will be specified for the new interfaces defined by P802.3bj as well as the Cu interfaces from IEEE Std 802.3ba-2010 as a new option
- Project biographic information and status
  - Name: IEEE P802.3bj 100 Gb/s Backplane and Copper Cable Task Force
  - Home: Under IEEE 802.3 Working Group at http://www.ieee802.org/3/bj/
  - Status: Working Group ballot

IEEE P802.3bk: Extended EPON

- What is this about (scope)?
  - Adding additional power budgets for EPON
    - 1G-EPON supporting a downstream channel insertion loss of 29dB, compatible with PR(X)30 upstream channel insertion loss;
    - 1G-EPON supporting a split ratio of at least 1:64 at a distance of at least 20 km
    - 10G-EPON, supporting a split ratio of at least 1:64 at a distance of at least 20 km
- Why should I be interested?
  - Extends EPON system budgets
- Project biographic information and status
  - Name: IEEE P802.3bk Extended Ethernet Passive Optical Networks Task Force
  - Home: Under IEEE 802.3 Working Group at http://www.ieee802.org/3/bk/
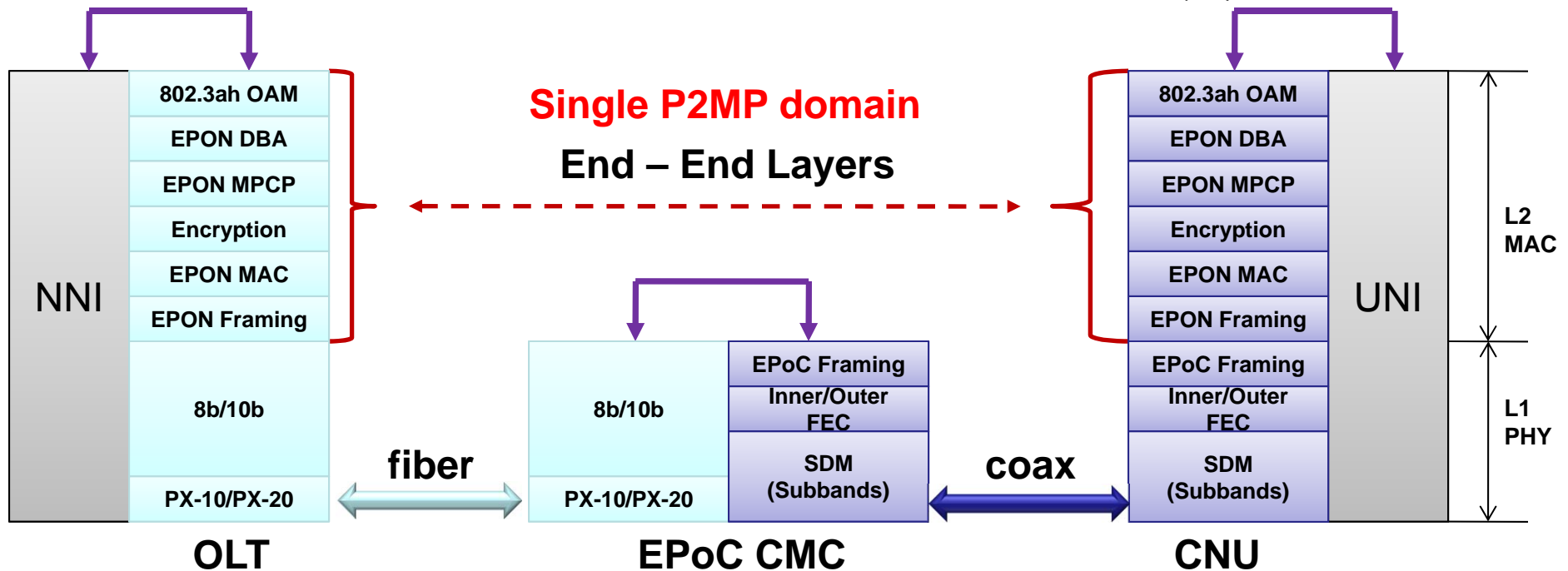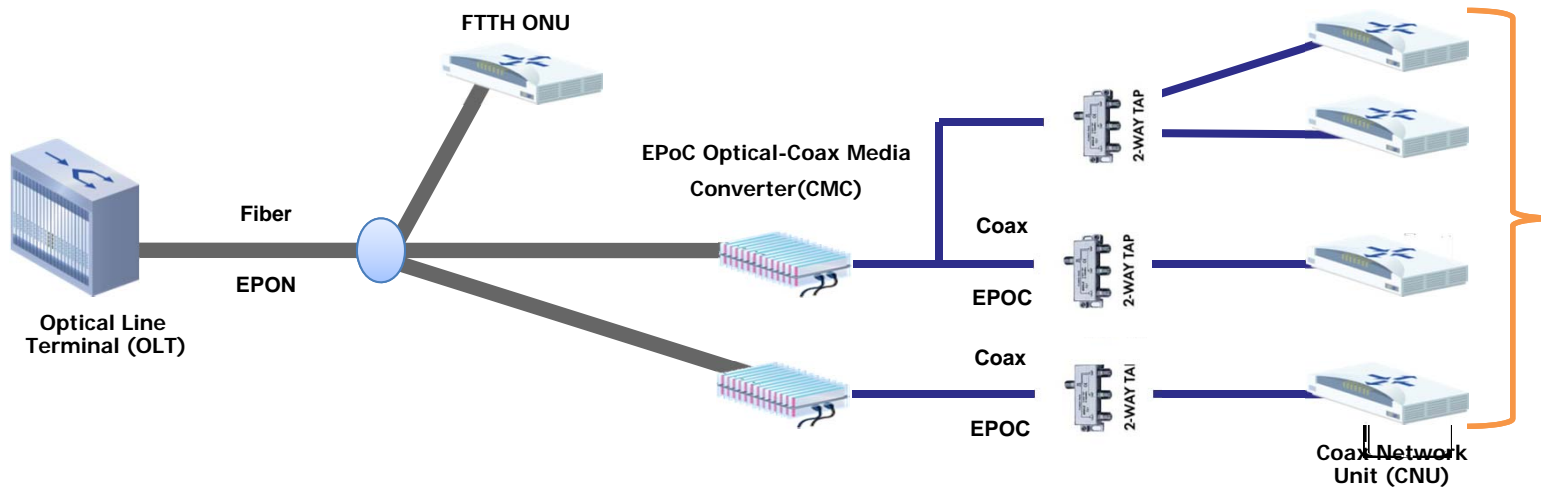 - Status: Sponsor ballot

IEEE P802.3bm: Next Gen 40G and 100G Optics

- ## What is this about (scope)?
  - Investigating next generation optical PMDs such as 100GBASE-SR4 and shorter reach ~1 km duplex SMF. In addition looking at a retimed interface (CAUI-4) very similar to scale down version of classic CAUI and CFP but operating over 4 lanes. Next generation plug will be based on CFP4/QSFP28 which will support passive CR4 cable, 100GBASE-SR4, and 100GBASE-LR4

- ## Why should I be interested?
  - Project is looking at higher density front panel interfaces to support bandwidth growth demand and to reduce cost and power of 40G and 100G optics.

- ## Project biographic information and status
  - Name: IEEE P802.3bm Next Generation 40Gb/s and 100Gb/s Optical Ethernet Task Force
  - Home: Under 802.3 Working Group at http://www.ieee802.org/3/bm/
  - Status: Task Force review anticipated out of May interim

IEEE P802.3bn: EPoC

- What is this about (scope)?
  - Developing a standards for Physical Layer Specifications and Management Parameters for Ethernet Passive Optical Networks Protocol over Coax (EPoC)

- Why should I be interested?
  - In the access space could allow a service provider that already deploys EPON protocol (MPCP) systems to transparently extend operation onto existing cable operator coaxial distribution networks

- Project biographic information and status
  - Name: IEEE P802.3bn EPoC PHY Task Force
  - Home: Under 802.3 at http://www.ieee802.org/3/bn
  - Status: Baseline selection
  - Availability of standard: anticipated late 2014

EPoC Overview

FTTH ONU

EPoC Optical-Coax Media Converter(CMC)

2-WAY TAP

2-WAY TAP

2-WAY TAP

Fiber

Coax

Coax

EPON

EPOC

EPOC

Optical Line Terminal (OLT)

Coax Network Unit (CNU)

Single P2MP domain

End – End Layers

NNI	802.3ah OAM
	EPON DBA
	EPON MPCP
	Encryption
	EPON MAC
	EPON Framing
	8b/10b
	PX-10/PX-20

OLT

fiber

8b/10b	EPoC Framing
	Inner/Outer FEC
PX-10/PX-20	SDM (Subbands)

EPoC CMC

coax

802.3ah OAM	UNI
EPON DBA	
EPON MPCP	
Encryption	
EPON MAC	
EPON Framing	
EPoC Framing	
Inner/Outer FEC	
SDM (Subbands)	

L2 MAC

L1 PHY

CNU

IEEE P802.3bp: RTPGE

- What is this about (scope)?
  - Gigabit Ethernet Twisted Pair PHY on less than 4-pairs for automotive channels

- Why should I be interested?
  - Must have to enable standard and next generation (Gigabit) automotive Ethernet by developing a 15m PHY for auto industry

- Key discussion topics in the group

- Project biographic information and status
  - Name: IEEE P802.3bp Reduced Twisted Pair PHY Task Force
  - Home: http://www.ieee802.org/3/RTPGE/index.html
  - Status: Baseline selection

IEEE P802.3bq: 40GBASE-T

- What is this about (scope)?

  – Next generation BASE-T PHY

- Why should I be interested?

  – Extends the standards roadmap for BASE-T!

  – Sweet spot for volume DC leaf node connections (servers to switches) as 40G transition occurs

  – Supports auto-neg for backward compatibility with 10G/1G to enable seamless DC upgrades

    - Can upgrade switch and servers separately

- Project biographic information and status

  – Home:
    http://www.ieee802.org/3/NGBASET/index.html

  – Status: SG expected to become a TF by May interim

Data Center Topologies

- ## Next Gen BASE-T well suited to cover Server to Switch connections within the row
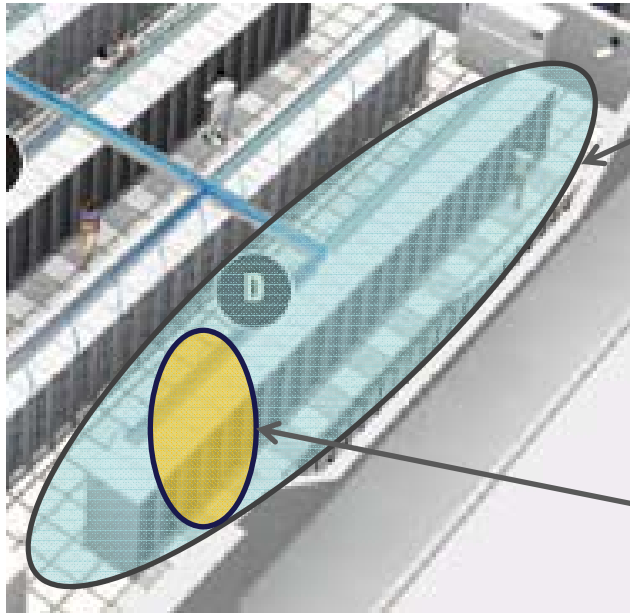
Distance served by NGBASE-T
- Within the rack
- Neighboring racks, stranded ports
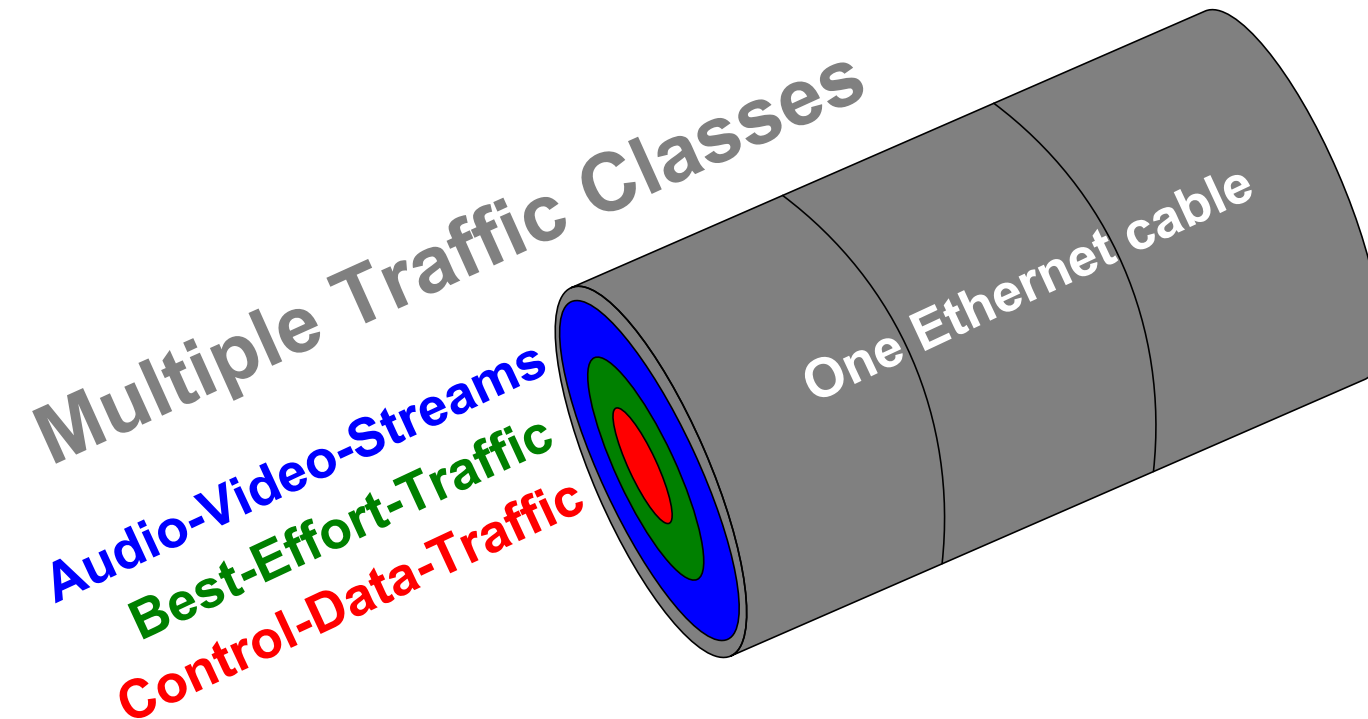- End of row

Distance served by CR4
- Within the rack
- Neighboring racks

*source: IEEE 802.3 NGBASET CFI

IEEE 802.3 DMLT Study Group

- What is this about (scope)?
  - Distinguished low latency Ethernet traffic support
- Why should I be interested?
  - Extends Ethernet into new markets
    - Industrial control
    - Automotive control
    - See:
      http://www.ieee802.org/3/minutes/jul12/0712_joint_802d1_802d3_close_report.pdf
- Project biographic information and status
  - Name: IEEE 802.3 Distinguished minimum latency traffic in a converged traffic environment Study Group
  - Home: http://www.ieee802.org/3/DMLT/index.html
  - Status: Study Group

Traffic Classes @ Converged traffic environment

Multiple Traffic Classes

Audio-Video-Streams
Best-Effort-Traffic
Control-Data-Traffic

One Ethernet cable

Only <u>one</u> network with guaranteed bandwidth and guaranteed minimum latency for

Control-Data-Traffic and Audio-Video-Streams

and do not violate Best-Effort-Traffic

*source: IEEE 802.3 DMLT CFI

IEEE 802.3 400G Study Group

- What is this about (scope)?
  - Next Ethernet rate and associated interfaces for 400G

- Why should I be interested?
  - Will shape the next higher speed Ethernet project
  - Great material on drivers, applications, customers, end-customers in this emerging space
    - http://www.ieee802.org/3/ad_hoc/bwa/BWA_Report.pdf

- Project biographic information and status
  - Name: IEEE 802.3 400 Gb/s Ethernet Study Group
  - Home: http://www.ieee802.org/3/400GSG/index.html
  - Status: Study Group created out of March 2013 plenary

The Server Roadmap
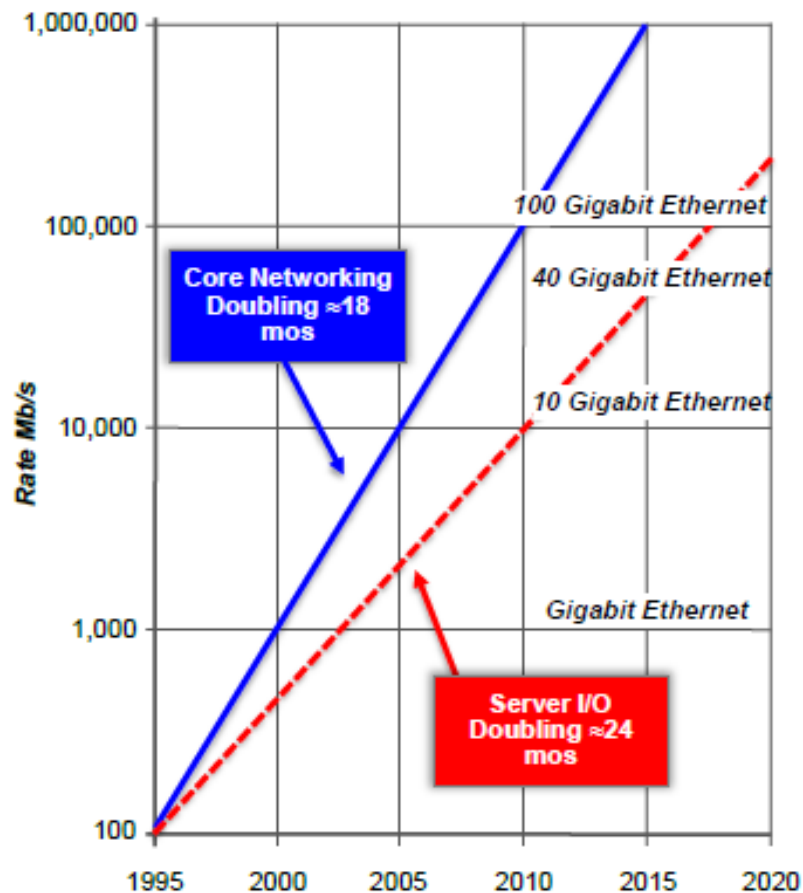
Server Upgrade Path
- 2014: 40 GbE
- 2017: 100 GbE

Blade Servers
- 802.3ba: 10 GbE to 40 GbE
- 802.3bj: 40 GbE to 100 GbE

Other Future Server I/Os
- 40GBASE-T
- 100GbE over MMF

*source: IEEE 802.3 400G CFI

IEEE 802.3 4-Pair PoE Study Group

- What is this about (scope)?
  - 4-Pair: Higher power / higher efficiency delivery
    - Will also look at enabling PoE over 10GBASE-T links
- Why should I be interested?
  - Extends the standards roadmap for PoE
  - Opens up new application spaces and markets for PoE
- Project biographic information and status
  - Name: IEEE 802.3 4-Pair PoE Study Group
  - Home: http://www.ieee802.org/3/4PPOE/index.html
  - Status: Study Group created out of Mar 2013 plenary
- Press release announcing project
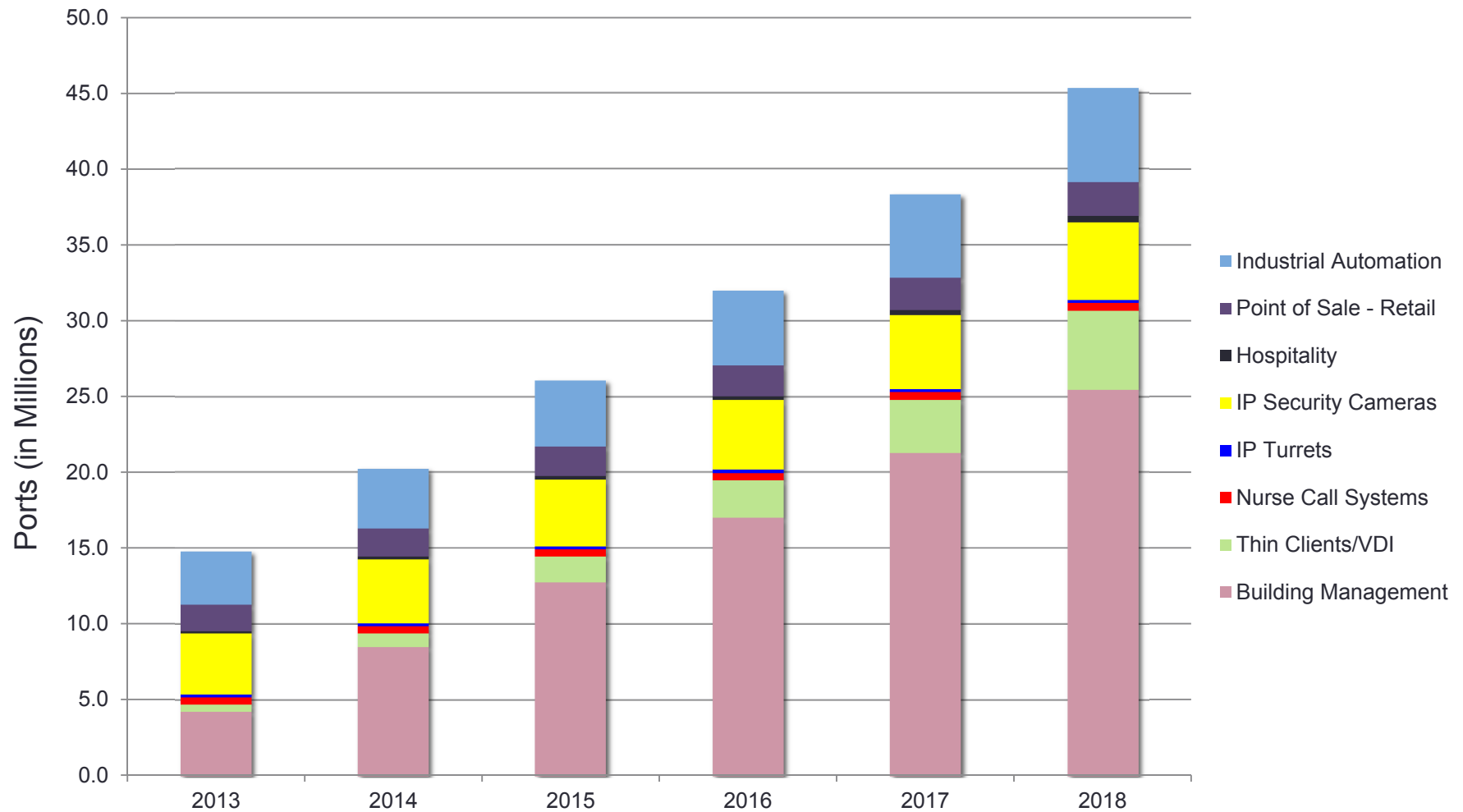 - http://standards.ieee.org/news/2013/4pair_poe.html

4-Pair High Power Target Markets

Markets	Typical Power Consumption
Nurse Call Systems - HealthCare	80% market needs >30W (Typically 50W)
Point Of Sale –Retail (POS – credit card readers and printers)	40-50% in 30-60W range
IP Turrets – Banking, financial trade floor phone systems	Typically 45W
Building Management (Lighting Fixtures & Controllers, Access Controllers, etc.)	40-50W
Thin Clients, Virtual Desktop Infrastructure(VDI) terminals (High-end configuration)	~50W
Video Conferencing, Hospitality (e.g.,: PoE powered switches)	Typically 45-60W
IP Security Cameras (Pan,Tilt,Zoom cameras)	30-60W range
Industrial (Brushless and Stepper drives, Motor control units)	>30W

*source: IEEE 802.3 4-Pir PoE CFI

4-Pair High Power Market Potential

Sources:
http://www.vdcresearch.com/media/pressRelease.aspx?pressID=1565
IMS Research - Jenalea Howell
http://seekingalpha.com/article/101408-the-global-lighting-market-by-the-numbers-courtesy-of-philips and other research reports
Gartner Forecasts, BT Turret, Cisco Partners

*source: IEEE 802.3 4-Pir PoE CFI

IEEE 802.3 PoDL CFI

- What is this about (scope)?
  - Power delivery for automotive
- Why should I be interested?
  - Opens up new application spaces for Ethernet in cars by leveraging RTPGE PHY
- Project biographic information and status
  - Home: IEEE 802.3 future projects
  - Status:
    - CFI scheduled for July 2013
    - See: http://www.ieee802.org/3/cfi/request_0713_1.html.

IEEE P802.3.1a: Ethernet MIB Revision

- What is this about (scope)?
  - Revision and update to the Ethernet MIB standard to synchronize with the 802.3 base standard 2012 revision
- Why should I be interested?
  - Ethernet management
  - Replaces and makes obsolete the IETF RFCs for Ethernet MIB modules, including Repeater, OAM, EPON, PoE, Etherlike-interface, EFMCu, WIS, MAU
  - New object identifiers (OIDs)
  - Syncs up with IEEE Std 802.3-2012
- Project biographic information and status
  - Name: IEEE P802.3.1 Revision to IEEE Std 802.3.1-2011 (IEEE 802.3.1a) Ethernet MIBs Task Force
  - Home: Under 802.3 Working Group at http://www.ieee802.org/3/1/
  - Status: Sponsor ballot

Agenda

Overview of IEEE Standards Education

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Ethernet's 40th Anniversary

Concluding remarks

Concluding Remarks SEC

What is it and what do we do?

Not the US Securities and Exchange Commission ☺

Joint program between IEEE's Standards Association and IEEE's Education Activities driving common initiatives. E.g....

    Promote standards and integration of standards into academia

    Provide learning materials including short courses

    http://www.standardseducation.org

How can I benefit from the SEC?

Free online tutorials and case studies

Student Mini-Grants (http://standardseducation.org/applications)

    $500 USD for students, *$300 USD* for faculty advisors

Global Standards Search Portal

IEEE Standards Education eZine

Concluding Remarks Ethernet

Ethernet is the ubiquitous wired connectivity
- < 0.01m to 1,000s of KMs
- 10Mb/s to 10Gb/s
- Backplane to fiber (and everything in between)

Ethernet is constantly evolving
- Expanding its rate-reach
- Expanding its scope e.g. EFM
- Projects go through a well defined process

Traditional and emerging application spaces *demanding* BW at lower cost structure
- Consumer, enterprise, data center and access

Standardizing on Ethernet enables emerging applications and their requirements *at low-cost with legacy support*
- Strong leverage and convergence of Ethernet
- Native powerful and simple layer 2 for access, aggregation, core...
- Leverage of growing technologies over Ethernet
  - EEE, AVB, HSE, MACSec, PoEP, FCoE
- Enables hybrid architectures to support legacy infrastructures

BACKUP

Kyoto, Japan, 25 April 2013

Standards and Policy Education

Standards and Policy Education at the IEEE-SA is part of larger IEEE activities in technology policy and education.

Technology policy:

IEEE as a thought leader driving new technology directions.

IEEE-SA will facilitate broad-based public discussion at a global level, and develop dialogue platforms and technology policy positions to inform and influence policy makers, industry, Civil Society and the scientific/technical community.

Standards education:

IEEE-SA works with IEEE Educational Activities to provide learning materials on the application of standards for university faculty and students and for practicing professionals engaging in continuing education.

IEEE-SIIT 2013 | THE 8TH INTERNATIONAL CONFERENCE ON STANDARDIZATION AND INNOVATION IN INFORMATION TECHNOLOGY

SIIT 2013 will have five program categories:

- Policy and regulations
- Standards case studies
- ICT standards
- Innovation & standardization research and methodologies
- Standards education

SIIT plans to evolve its content and scope as we uncover key research concerns of interest to the standards stakeholder communities.

SIIT 2013 to be hosted by ETSI in Sophia-Antipolis, France, 9/24-26.

Attendees from academia, government and corporate world; geographically diverse.

Industry participation & sponsorship: Microsoft, Oracle, IBM, Adobe, RIM.